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A survey of visible light communication

Divya Kiran Xalxo[1], Muralidharan V[2]

1. ECE, Christ the King Engineering College, Karamadai, Coimbatore, Email: Kiran.xalxo17@gmail.com
2. Assistant Professor, ECE Department, Christ the King Engineering College, Karamadai, Coimbatore, Email: muralivlsi5@gmail.com

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ABSTRACT

Light Emitting diodes (LED) are used in different areas of everyday life. The advantage of this device is that in addition to their data transmissions as well. For every minute number of devices using wireless technology is increasing. These wireless technologies use radio waves for transmission which is harmful to human health and environment. Visible Light Communication (VLC) is globally recognized as an advanced and promising technology to realize short-range, high speed and large capacity wireless data transmission. Light-emitting diode (LED) bulbs transmit data when they are switched on and off so rapidly in nanoseconds, that the human eye cannot see it. This data is registered by special equipment, making it possible to provide wireless Internet connectivity

.Li-Fi has just been tested in the real world that it can provide data transmission at 1 GB per second-that's it is 100 times faster than current average Wi-Fi speed.

Keywords: LED (Light emitted diode), VLC, Wi-Fi.

1. INTRODUCTION

'Internet of Things' is an optical communication technology that's taking the world by storm. Light Fidelity or Li-Fi, is an exciting breakthrough in 5G visual light communication systems and the future of wireless Internet access. With Li-Fi, information hitches a ride along a spectrum of visible light. Light-emitting diode (LED) bulbs transmit data when they are switched on and off so rapidly in nanoseconds, that the human eye cannot see it. This data is registered by special equipment, making it possible to provide wireless Internet connectivity at a current experimental speed up to 10 Gbps, which is estimated to be 250 times faster than 'superfast' broadband. The vast availability of LED light bulbs will drive the future Ubiquity of connectivity even in places where Wi-Fi fails—on and airplane and in submarines, for example. Another advantage of Li-Fi is zero electromagnetic interference, allowing connectivity even in areas where Wi-Fi isn't accepted — hospitals and nuclear plants among others. In addition, Li-Fi offers better data defense as light waves can't pass through walls, making it impossible to hack any internal systems in the LED is on, you transmit a digital 1, if it's off you a 0. The LEDs can be switched on and off very quickly which is a good opportunity for transmitting a data. As radio waves used by Wi-Fi get more congested and the demand for faster and more efficient wireless communication escalates, the future is bright for Li-Fi as a reliable, affordable and more secure solution. Smart phones will soon be able to download traffic information from traffic lights or a program guide from a television.

2. WORKING TECHNOLOGY

This brilliant idea was first showcased by Harald Haas from University of Edinburgh, UK, in his TED Global talk on VLC. He explained," Very simple, if the LED is on, you transmit a digital 1, if it's off you transmit a 0. The LEDs can be switched on and off very quickly, which gives nice opportunities for transmitting data." So what you require at all are some LEDs and a controller that code data into those LEDs. We have to just vary the rate at which the LED's flicker depending upon the data we want to encode. Further enhancements can be made in this method, like using an array of LEDs for parallel data transmission, or using mixtures of red, green and blue LEDs to alter the light's frequency with each frequency encoding a different data channel. Such advancements promise a theoretical speed of 10 Gbps – meaning you can download a full high-definition film in just 30 seconds. Simply awesome! But blazingly fast data rates and depleting bandwidths worldwide are not the only reasons that give this technology an upper hand. Since Li-Fi uses just the light, it can be used safely in aircrafts and hospitals that are prone to interference from radio waves. This can even work underwater where Wi-Fi fails completely, thereby throwing open endless opportunities for military operations. Radio waves are replaced by light waves in a new method of data transmission which is being called Li-Fi. Light-emitting diodes can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously. A flickering light can be incredibly annoying, but has turned out to have its upside, being precisely what makes it possible to use light for wireless data transmission. Light emitting diodes can be switched on and off faster than the human eye can detect, causing the light source to appear to be on continuously, even though it is in fact 'flickering'. This invisible on-off activity enables a kind of data transmission using binary codes: switching on an LED is a logical '1', switching it off is a logical '0'. Information can therefore be encoded in the light by varying the rate at which the LEDs flicker on and off to give different strings of 1s and 0s. This method of using rapid pulses of light to transmit information wirelessly is technically referred to as Visible Light Communication (VLC), though it's potential to compete with conventional Wi-Fi has inspired the popular characterization Li-Fi. LiFi (Light Fidelity) is a fast and cheap optical version of Wi-Fi, the technology of which is based on Visible Light Communication (VLC).VLC is a data communication medium, which uses visible light between 400 THz (780 nm) and 800 THz (375 nm) as optical carrier for data transmission and illumination. It uses fast pulses of light to transmit information wirelessly as the flickering rate is so fast, the LED output appears constant to the human eye. A data rate of greater than 100 Mbps is possible by using LED arrays where each LED transmits a different data stream.

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3. PARTS OF VLC

The VLC consists of following major blocks:

A. Visual Basic Interface

The interface transmits the data bits serially via the PC RS-232 port. At the receiver, it receives all the data bits serially via the photodiode.

B. Serial Port MAX 232

MAX 232 is 16 pins IC, which converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. At the receiver it again converts back the TTL logic levels back to serial signal levels.

C. RS-232

In communications, RS-232 is a standard for serial binary data interconnection between a *DTE* (Data terminal equipment) and a *DCE* (Data Circuit-terminating Equipment). It is commonly used in computer serial ports.

D. Microcontroller ATMEGA 162

It receives the signals at TTL levels at various ports and converts this data to binary form. At the receiver, it again converts the binary data to decimal data.

E. LED

This acts as a light source which transmits the binary output of the microcontroller in the form of light intensity pattern which is then transmitted.

I Choose LED to transmit the data, because it has the following reasons

- Best-in-class energy savings Real-time energy management.
- Building performance monitoring and enhanced workplace productivity.
- Reduced installation, Commissioning and maintenance costs.

F. Light Dependent Resistor – LDR

Two cadmium sulphide (cds) photoconductive cells with spectral responses similar to that of the human eye. The cell resistance falls with increasing light intensity. Applications include smoke detection, automatic lighting control, and batch counting and burglar alarm systems. Photoconductive cells are used in many different types of circuits.

G. Photo Diode

A photodiode is a semiconductor device that converts light into current. The current is generated when photons are absorbed in the photodiode. A small amount of current is also produced when no light is present. Photodiodes may contain optical filters, built-in lenses, and may have large or small surface areas. Photodiodes usually have a slower response time as their surface area increases. The common, traditional solar cell used to generate electric solar power is a large area photodiode.

H. Power Supply

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ca voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

4. AUDIO TRANSMISSION

The light emitter is a simple, off-the shelf LED obtained from Cree (XLamp MX-6) which provides a luminous flux of 107 lm at the current of 350 mA. A Reflection cup is mounted on each LED for the purpose of gaining light that is more parallel and concentrated. Video and audio signal captured by video camera are amplified by a self-designed amplifier and then superimposed onto two LED lamps respectively by the aid of a bias-T circuit. Thus, the output light rays changes in intensity corresponding to the variation in

signal, which however is insensitive to human eyes due to the rapid frequency response of LED devices. The distance between two LEDs was about 10 cm in order to avoid mutual interference caused by light sources. At the receiver, two highly sensitive Si PIN photodiodes (Hamamatsu S6968) are used to detect light transmitted over two separate optical channels. And the directionality of the PDs is required to be aligned with the most intense portion of the emitted light beams. After detection, optical signals are converted into photo electric current proportional to the variation of incident light which then is amplified and filtered by a low pass filter (LPF). An audio and video capture module with USB interface is designed to convert the received analog signal into digital signal. Finally, the video and audio are played real time on the screen of a video editor for further processing such as simple cutting, filtering or storing. In the proto-type, transmission distance of nearly 2 m can be achieved without any light focusing measures and can be increased to 3 m with a focusing lens inserted between the trans-mitter and receiver.

5. CIRCUIT DESIGN

Figure 2 Circuit Board Final

6. FEATURES OF LI-FI

- Up to ~4000 lumen output (can be used in both collimated mode for LCD/LoS, and focused mode for DLP). 20,000+ lifetime (about 5x longer than conventional UHP lamps).Up to 10x faster turn on rate.
- Dynamic brightness control (can be electronically dimmed between 20-100%). Nominal power use: 270W (includes microwave transmitter).
- Dimensions: 5.3" x 3.6" x 6.8" (135 x 91 x 173mm.
- Li- Fi uses light rather than radio frequency signals.VLC could be used safely in aircraft.
- There are around 19 billion bulbs worldwide, they just need to be replaced with LED ones that transmit data. We reckon VLC is at a factor of ten, cheaper than WI-FI.
- Security is another benefit; light does not penetrate through walls.
- In streets for traffic control. Cars have LED based headlights, LED based backlights, and Car can communicate each other and prevent accidents in the way that they exchange Information. Traffic light can communicate to the car and so on. By implementing the Technology worldwide every street lamp would be a free access point.
- High speed, as high as 500mbps or 30GB per minute.
- Integrated into medical devices and in hospitals as this technology does not deal with radio waves, so it can easily be used in such places where Bluetooth, infrared, Wi-Fi and internet are banned. In this way, it will be most helpful transferring medium

for us.

- Under water in sea Wi-Fi does not work at. Li-Fi may solve issues such as the shortage of radio frequency bandwidth.

7. APPLICATIONS AREA OF Li-Fi

Airways:- Whenever we travel through airways we Face the problem in communication media, because the whole airways communication are performed on the basis of radio waves.

Green Information Technology:- It means that unlike Radio waves and other communication waves affects on birds, human bodies etc. LI-FI never gives such side effects on any living things.

Free From Frequency Bandwidth Problem:- Communication media in the form of light so it does not require any bandwidth i.e. we don't need to pay any amount for communication and license.

Increase Communication Safety: - The node attach to our network is visible to the host of network due to visual light communication.

Multi User Communication: - Li-fi helps to share multiple things at a single instance called broadcast

Lightings Points:- Light device like car lights, ceiling lights, street lamps area able to spread internet connectivity.

Smarter Power Plants:- power plants need fast, inter-connected data systems to monitor things.

8. CONCLUSION

There are a plethora of possibilities to be gouged upon in this field of technology. If this technology becomes justifiably marketed then every bulb can be used analogous to a Wi-Fi hotspot to transmit data wirelessly. By virtue of this we can ameliorate to a greener, cleaner, safer and a resplendent future. The concept of Li-Fi is attracting a lot of eye-balls because it offers a genuine and very efficient alternative to radio based wireless. It has a bright chance to replace the traditional Wi-Fi because as an ever increasing population is using wireless internet, the airwaves are becoming increasingly clogged, making it more and more difficult to get a reliable, high-speed signal. This concept promises to solve issues such as the shortage of radio-frequency bandwidth and boot out the disadvantages of Wi-Fi. Li-Fi is the upcoming and on growing technology acting as competent for various other developing and already invented technologies. Hence the future applications of the Li-Fi can be predicted and extended to different platforms and various walks of human life.

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